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TAXOCARD Game in Promoting Concept Retention in Mastering Animal Classification

Nikko Lorenz P. Lawsin^{1*}

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ABSTRACT

Concept retention is important in studying biology concepts, especially in learning animal classification. Several complex concepts and vocabulary of biology classes require memory work to easily remember and relate their knowledge on distinguishing characteristics of each group of organisms. This study aimed to develop an educational card game, TAXOCARD Game, and utilize them in class to promote concept retention towards learning animal classification. The content expert validators evaluated the developed TAXOCARD Game in biology and students who are enrolled in grade 8 science in terms of its goals and objectives, card design, components and organization, playability and playfulness, and usefulness. Based on the evaluation after using TAXOCARD Game, both content expert validators and students gave a remark of outstanding, and positively viewed that TAXOCARD Game can be an effective tool to encourage the students to interact with their classmates and promote concept mastery because of repetitive actions. This study recommends using this TAXOCARD Game in grade 8 science class to further improve this innovative craft. It is strongly recommended to other biology teachers to design and develop other educational card games in biology that they perceive requires high concept retention yet can be enjoyed when such intervention is incorporated.

INTRODUCTION

In the Philippines science education curriculum, animal classification is taught in the last quarter of grade 8 science. In this lesson, it requires a lot of memory work because of the terminologies that are used such as the names of animal phyla, its classes, and the shared distinguishing characteristics without losing student interest in learning this immense knowledge within a given time. In the local study of Santos *et al.*, (2021), classifying organisms using the hierarchical taxonomic system obtained a remark of low mastery among the listed students' least mastered competencies in Grade 8 biology. In the study of Chylenska and Rybska (2018) wherein they investigated the students' understanding and attitude towards the topic of classification, the students appreciate the value of animal classification, but they find it difficult to classify and apply its principles. In the study of Kilic (2016) wherein the author investigated the conceptual structures and reasoning patterns on the animal classification of the pre-service teachers, the participants prioritized the distinguishing characteristics of animals, however there are some erroneous information and alternative conceptions examined on students' way of classifying them.

Many educators incorporate game-based learning strategies to promote student conceptual understanding as well as student engagement that leads to concept mastery (Piyawattanaviroj, *et al.*, 2019). Game-based learning can be defined as an integration of traditional or digital games parallel to the educational objectives to keep students engaged and motivated (Nadolny, *et al.*, 2020). Game-based learning is becoming popular in both K-12 schools and colleges (Shu and Liu, 2019). It becomes clearer that the role of games in education and

classroom teaching makes students more active, capable of making strategic decisions to solve problems, and enjoys the whole conduct of the game (Spiegel, *et al.*, 2008; Selvi and Cosan, 2018). Also, educational games can be considered an effective and interactive teaching strategy in supporting traditional teaching approaches in terms of educators' responsibility that eventually inspires and boosts the student's motivation to learn and makes the learning process fun as it encourages teamwork (Lujan and DiCarlo, 2006; Su, 2014).

Pieces of literature have reported that games can serve as a practical tool to aid learners of all ages retain knowledge and build critical thinking. Educational card games in teaching protein purification techniques in molecular biology allowed the students to assess, increase, and apply their knowledge, developed skills in communication, and enjoyed the experience of its utilization (Barnes, 2020). The developed Botanical Phylo-card Game to infuse disciplinary fundamental ideas about biodiversity, evolution, and common ancestry so students learned how scientists organize taxa into meaningful biological patterns of plant evolution (Gibson & Cooper, 2017). Based on the study of Gutierrez (2014), the supplement of card game is more effective than traditional teaching methods and it helps the students to learn complex concepts and vocabulary of biology classes. In the study of Punyasettro and Yasri (2021), it showed that students positively viewed the usefulness of the developed card game as a tool in reviewing their lessons and as a form of a learning activity in other topics in biology.

To address the research gap and student's needs, this study aimed to develop an educational card game, TAXOCARD Game, to validate the developed educational card game

¹ Department of Biology, College of Science, De La Salle University, Manila, and College of Medicine, Ospital ng Muntinlupa Medical Center, Muntinlupa, Philippines

* Corresponding author's e-mail: nikkolorenzlawsin@plmun.edu.ph

with content expert validators, and to utilize these validated TAXOCARD in grade 8 class in terms of promoting concept retention and student engagement towards the learning of animal classification. The study aimed to improve teachers' teaching practices in designing and developing instructional materials that can improve student mastery on the content while maintaining their engagement in the teaching and learning process.

METHODOLOGY

Research Design

This study utilized two research designs to meet the objectives of the study. It utilized (1) development research design, in which it developed the TAXOCARD Game and determined quantitatively its content and

quality as perceived by the content expert validators in terms of its goals and objectives, card design, components and organization, playability and playfulness, and usefulness (Gutierrez, 2014). During the pilot testing, the study used a counter balanced experimental research design in which the two groups alternately utilized the TAXOCARD Game as the experimental variable, and the required worksheets as the control variable, see figure 1 (Sarmiento, 2017). The sessions 1 to 3 covered the topic about Phylum Porifera and Cnidaria; the sessions 4 to 6 covered the topic about the Phylum Platyhelminthes, Nematoda, and Annelida; the session 7 to 8 covered the topic about the Phylum Mollusca and Arthropoda; and, the sessions 9 to 10 covered the topic on Phylum Echinodermata and Chordata.

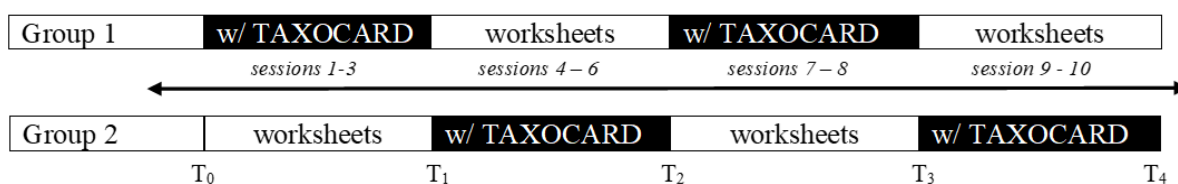


Figure 1: Counterbalanced experimental research design

METHODOLOGY

Material Development

The educational card game, TAXOCARD Game, was designed and developed based on the adapted protocol of Gutierrez (2014) in which the author designed an educational card game on selected human body systems. The protocol consists of the preparatory stage, game development, card design, game rules, revision, and pilot testing, see Figure 2. In the preparatory stage, conceptualizing and planning on how the TAXOCARD Game can be utilized in classroom teaching through assessing the current methods of instructions, analyzing the student's needs and interests, and identifying the problems in the delivery of teaching and learning process including the preparations of materials and other necessary components of the game.

In the game development stage, the breadth and depth of the topics on animal classification were identified. The key terms encompassing the distinguishing and shared characteristics of animal phyla and classes were listed and systematically organized to tabulate in preparation

for the card's content. In designing the physical layout of the card, it was crafted in Microsoft PowerPoint 2019 for practical purposes due to its availability and user-friendly features in designing instructional materials, see figure 3. In terms of the game rules or its mechanics, it was crafted based on the rules of matching pairs, match-up, simply pairs, or pares-pares (a popular Filipino card game) in which the players of the game should only pair the cards containing the picture and name of the species with the distinguishing characteristics and their taxonomic groups -- phyla and classes. There are corresponding points being assigned to each card. All nine phyla have 1 assigned point, while the points for organisms and distinguishing characteristics varied based on the difficulty level for classifications. The sum of its points will be added to the player who correctly pairs the set of cards while there will be deduction of points once the classification is incorrect. After the design and development of the TAXOCARD, it was validated by the content expert validators using the 25-item evaluation criteria used in Gutierrez (2014).

In the revision and implementation stage, the comments

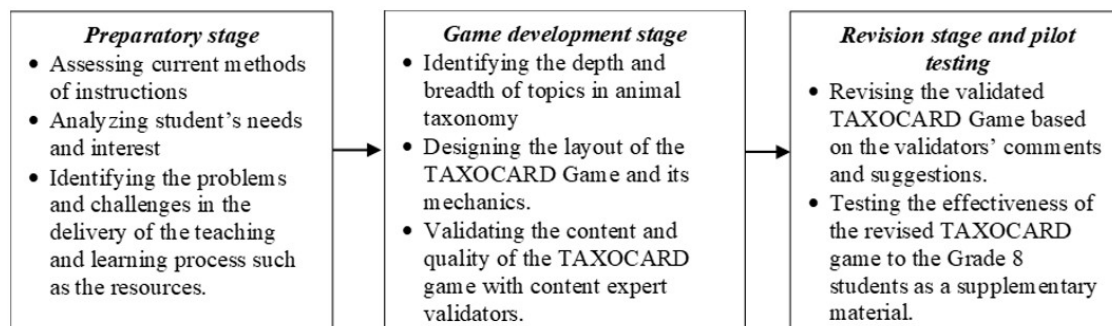


Figure 2: Material Development Protocol adapted from Gutierrez (2014)

and suggestions of the content expert validator were considered to improve the overall quality of TAXOCARD

game and after the revisions, it was pilot tested to the two groups of grade 8 students.



Figure 3: Sample layout of the TAXOCARD Game

Participants of the study

This study included content expert validators to evaluate the content and quality of the developed TAXOCARD Game in terms of goals and objectives, card design, components and organization, playability and playfulness, and usefulness. The 4 content expert validators were purposively chosen as science teachers with at least 5 years of teaching experience in grade 8 biology and have also developed strategic instructional materials (SIM) during their teaching experience. There are also two groups (n=67 students) of grade 8 students that were selected as participants in the study.

Research Instruments

To fulfill the study's objectives, the following research instruments were utilized: (1) Evaluation Tool for TAXOCARD Game. This 25-item rating scale was adapted from Gutierrez (2014) wherein the author utilized this instrument to determine the effectiveness of card games as supplementary materials in teaching selected topics in biology. This instrument was utilized by the 4 content expert validators and 67 students during the implementation. (2) Pretest/posttest concept inventory. These validated 40-item concept tests were administered to the students before and after the implementation of the

study to determine its effect on their concept retention.

Data Gathering Procedure

During the content expert validation, the numerical evaluation was tabulated, and the comments and suggestions were summarized and utilized to improve the quality of the TAXOCARD game. The personal information of these experts was anonymized and only their professional affiliations, educational attainment, and years of teaching services were disclosed to ensure the qualifications of the content experts. In the implementation stage, students were asked to sign the consent form agreeing that they served as the research participants, and they were informed that their responses would be utilized for research purposes only. The pretest (T0) was administered to the students to determine their initial knowledge, while successive posttests (T1-T4) were given at the end of sessions 3, 6, 8, and 10 to measure the concept retention of the students throughout the intervention. At the end of the data collection, all results and analyses were disclosed and discussed with the teacher for the debriefing process of the students. The student scores were initially tallied in MS Excel 2019 version and then processed in SPSS version 21 for the statistical treatment of data.

RESULTS AND DISCUSSION

Problem 1

What is the evaluation of the content-expert validators and students in terms of quality of TAXOCARD Game? Table 1 summarizes the descriptive evaluation of the content-experts and students towards the quality of the TAXOCARD Game. Based on the summarized results, the developed TAXOCARD game is evaluated by the content-expert validators and students to be outstanding in terms of its criteria on goals and objectives, designs, components and organization, playability and playfulness, and its usefulness. In the first criteria – goals and objectives obtained overall remarks of outstanding both from the content-expert validators and students. In content-expert validation, 4 out of 6 items obtained a remark of outstanding, while 2 out of 6 items obtained a remark of very satisfactory.

In the result of student validation during the implementation of study, all items obtained outstanding remarks. This result is related to the study of Gutierrez (2014) that utilization of card games had positive impact on thought process, concept retention, and student interactions. In the second criteria – the card design also obtained overall remarks of outstanding both from the content-expert validators and students. It obtained 2 very satisfactory and 3 outstanding remarks from the content-expert validators. While it obtained 5 outstanding remarks from the students. This means that the 2 groups of evaluators evidently appreciate the card designs including its size, embedded photos, appearance of the cards, and available references.

This evaluation is parallel with the article written by Reeves (2015), wherein the play of memory card games with creative and organized design has significant contributions in longevity of student attention span. In the third criteria – the card components and organization also obtained overall remarks of outstanding both from the content-expert validators and students. It obtained 1 very satisfactory and 4 outstanding remarks from the content-expert validators. While it obtained 3 very satisfactory and 2 outstanding remarks from the students. This means that the 2 groups of evaluators clearly understood the directions and mechanics of the TAXOCARD games, the key points were emphasized to them, the choice of words were appropriate to the learners. Based on facets 15 and 16, students found the need to improve the number of card games on the deck

to increase the length of the playing time.

This evaluation is in synergy with the results of the study conducted by Pho and Dinscore (2015), wherein the utilization of card games with its organization, mechanics, and the concepts behind it significantly increase the student engagement throughout the game. In the fourth criteria – the card playability and playfulness also obtained overall remarks of outstanding both from the content-expert validators and students. It obtained 1 very satisfactory remark and 3 outstanding remarks from the content-expert validators. While it obtained 4 outstanding remarks from the students. This means that the 2 groups of evaluators obviously perceived the positive impacts of TAXOCARD game as it promoted fair, healthy competition, and cooperation during utilization. This evaluation exhibited identity with the results of the study conducted by Singh *et al.*, (2021), wherein it emphasized that the card game is a strong tool that improved the student performance while meaningfully engaged and enjoyed during the interaction and playing of the card game. In the fifth criteria – the card usefulness also obtained overall remarks of outstanding both from the content-expert validators and students.

It obtained 2 very satisfactory remarks and 3 outstanding remarks from the content-expert validators. While it obtained 5 outstanding remarks from the students. This means that the 2 groups of evaluators manifestly value the card usefulness in reinforcing the concepts of animal taxonomy for grade 8 students as this card game served as their review materials, encouraged them to think deeper, and connect the relationships of content or subject-matter of the topic. This evaluation is incoherence with the review article conducted by Nguyen, (2021), wherein the author highlighted that the use of games in teaching increases student participation, fosters social and emotional learning, and motivates the students to take risks. The result of this study shows significant similarities on the concept retention measured in the of Punyasettro and Yasri (2021) wherein they concluded that the developed VERT' card game promoted conceptual understanding of chordates' phylogeny and self-efficacy to learn evolutionary biology. This innovation lays the foundation of different chordates characteristics, and it enhanced the students' learning of the chordate phylogenetic taxonomy as they allow students to create and interpret the evolutionary relationships based on the phylogenetic tree.

Table 1: Descriptive evaluation of content-expert validators and students towards the TAXOCARD Game

Items		Mean Scores	
		Content Expert Validators	Students
Goals and Objectives			
1	The purpose and rationale for the game are fully explained.	4.75 (Outstanding)	4.87 (Outstanding)
2	The goals and objectives of the game are clearly defined.	4.50 (Very satisfactory)	4.72 (Outstanding)
3	The game was thought provoking.	4.75 (Outstanding)	4.59 (Outstanding)
4	The game encouraged student interaction.	4.75 (Outstanding)	4.84 (Outstanding)
5	The game promoted discussion of key topics.	4.25 (Very satisfactory)	4.51 (Outstanding)

6	The card game helps with my recall of concepts/terms.	4.75 (Outstanding)	4.93 (Outstanding)
Average mean		4.63 (Outstanding)	4.74 (Outstanding)
Card design			
7	Card size is appropriate.	4.25 (Very satisfactory)	4.63 (Outstanding)
8	Online reference of the pictures was available.	5.00 (Outstanding)	4.78 (Outstanding)
9	The picture printed on the card is representative of the topic.	4.75 (Outstanding)	4.91 (Outstanding)
10	The material used (paper) in the preparation of the cards is durable.	4.50 (Very satisfactory)	4.77 (Outstanding)
11	The deck of cards is compact and can be easily carried around.	4.75 (Outstanding)	4.83 (Outstanding)
Average mean		4.65 (Outstanding)	4.78 (Outstanding)
Components and organization			
12	The directions were clear, concise, and easily understood.	4.50 (Very satisfactory)	4.76 (Outstanding)
13	The game emphasized key points of the topic played.	4.75 (Outstanding)	5.00 (Outstanding)
14	The terms used were appropriate to my level of knowledge.	5.00 (Outstanding)	5.00 (Outstanding)
15	The number of cards was appropriate.	4.75 (Outstanding)	4.42 (Very satisfactory)
16	The length of time required to play the game is reasonable.	5.00 (Outstanding)	4.38 (Very satisfactory)
Average mean		4.80 (Outstanding)	4.71 (Outstanding)
Playability and playfulness			
17	The game provides opportunity for healthy competition and cooperation.	4.25 (Very satisfactory)	4.67 (Outstanding)
18	The rules of the game provide players with equal conditions for a fair play.	5.00 (Outstanding)	4.88 (Outstanding)
19	The rules of the game provide a set of options for flexibility in making decisions when playing the game.	5.00 (Outstanding)	4.71 (Outstanding)
20	Playing the game was fun.	4.75 (Outstanding)	4.90 (Outstanding)
Average mean		4.75 (Outstanding)	4.79 (Outstanding)
Usefulness			
21	The game was effective in reviewing the material.	5.00 (Outstanding)	4.84 (Outstanding)
22	The game encouraged the players to dig deeper into the subject matter.	4.25 (Very satisfactory)	4.34 (Very satisfactory)
23	Playing the game is a productive use of time.	4.50 (Very satisfactory)	5.00 (Outstanding)
24	Playing the game helped me establish better relationships with the members of the group	5.00 (Outstanding)	4.42 (Very satisfactory)
25	I would recommend the game to my peers.	5.00 (Outstanding)	4.87 (Outstanding)
Average mean		4.75 (Outstanding)	4.69 (Outstanding)
Overall mean		4.72 (Outstanding)	4.74 (Outstanding)

Note: 4.51-5.00 – Outstanding; 3.76–4.50 – Very satisfactory; 3.01-3.75 – Satisfactory; 2.26-3.00 – below satisfactory; 1.00-2.25 - Poor

These finding exhibits coherence with Selvi and Cosan (2018) study as they investigated how the scientific educational games contributed and enhanced the students' academic achievement and retention of knowledge about the Kingdoms of Living Things using the score in the posttest and retention test. In the similar study, the students found the games entertaining, informative, and reinforcing their learning, and concluded that it is effective in the retention of knowledge, promotion of peer collaboration, and increase in their interest and motivation for learning.

Problem 2

What is the effect of utilizing TAXOCARD game on student concept retention?

Table 2 shows the summary of the differences on the match-paired grade 8 pretests and posttests of the students during the implementation of the study. Group 1 obtained mean scores of 7.12 and 24.92 in their pretest and posttest, respectively, while group 2 obtained mean scores of 6.43 and 22.71 in their pretest and posttest. In the alternating utilization of the TAXOCARD game and the prescribed worksheet, it was found out that there

Table 2: Difference on matched Grade 8 pretests and the posttests using counterbalanced research design

Groups	Mean Scores		Welch F-value	P-value	Decision on null Hypothesis	Remarks
	Pretest	Posttest				
1	7.12 (1.630)	24.92 (3.946)	1.425	0.376	Accept the null	There is no significant difference between the pretests and posttests
2	6.43 (2.278)	22.71 (4.082)				

Note: Standard deviations are in the parentheses

was no significant difference between their match-paired pretests and posttests mean scores using Welch F-test as p-value is greater than 0.05 ($p > 0.05$). It can be inferred that the TAXOCARD game can be an alternative instructional material in teaching animal taxonomy in grade 8 science. It means that the developed card game can be a good supplementary material for this topic to enrich student's experience towards animal classification. This result shares common experience with the study of Gutierrez (2014), wherein the researcher utilized card games as supplementary materials in teaching selected topics in biology. Based on the result of this study, it was found out that card game is an effective supplementary material compared to traditional teaching methods.

CONCLUSION AND RECOMMENDATIONS

Based on the findings, it was found out that the TAXOCARD Game is an outstanding supplementary tool in teaching animal taxonomy as evaluated by the content-expert validators. This can be an effective tool to encourage the students to interact with their classmates and promote concept retention and mastery because of repetitive actions. In the conduct of the study, analyzing the learners and addressing their learning needs are the two main considerations that teachers mainly pay attention to their instructions to ensure that the instructional delivery is aligned to their needs and captures their interests. Thus, the researcher of the study recommends using this TAXOCARD Game in grade 8 science class to further improve this innovative craft. It is also strongly recommended that other biology teachers design and develop other educational card games in biology that they perceive require high concept retention yet can be enjoyed when such intervention is incorporated.

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